Semantics and Ontology: On the Modal Structure of an Epistemic Theory of Meaning

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In this paper I shall confront three basic questions.

First, the relevance of epistemic structures, as formalized and dealt with by current epistemic logics, for a general Theory of meaning. Here I acknowledge M. Dummett's idea that a systematic account of what is meaning of an arbitrary language subsystem must especially take into account the inferential components of meaning itself. That is, an analysis of meaning comprehension processes, given in terms of epistemic logics and semantics for epistemic notions.

The second and third questions relate to the ontological and epistemological framework for this approach. Concerning the epistemological aspects of an epistemic theory of meaning, the question is: how epistemic logics can eventually account for the informative character of meaning comprehension processes. "Information" seems to be built in the very formal structure of epistemic processes, and should be exhibited in modal and possible-world semantics for propositional knowledge and belief. However, it is not yet clear what is e.g. a possible world. That is: how it can be defined semantically, other than by accessibility rules which merely define it by considering its set-theoretic relations with other sets-possible worlds. Therefore, it is not clear which is the epistemological *status* of propositional information contained in the structural aspects of possible world semantics. The problem here seems to be what kind of meaning one attributes to the modal notion of possibility, thus allowing semantical and synctactical selectors for possibilities. This is a typically Dummett-style problem.

The third question is linked with this epistemological problem, since it is its ontological counterpart. It concerns the *limits* of the logical space and of logical semantics for a of meaning. That is, it is concerned with the kind of structure described by inferential processes, thought, in a fregean perspective, as pre-conditions of estentional treatment of meaning itself. The second and third questions relate to some observations in Wittgenstein's *Tractatus*. I shall also try to show how their behaviour limits the explicative power of some semantics for epistemic logics (Konolige's and Levesque's for knowledge and belief).

1. Relevance of epistemic modal notions and inferences for a Theory of meaning

Dummett's basic idea is that a systematic and non-modest theory of meaning must account for what it means to understand a statement. In Dummett's view, this account must possibly support a constructive metaphysical option. But as stated in *The logical basis of Metaphysics*, metaphysical questions and statements themselves depend on semantic assumptions and pre-semantics ways of considering formal structures relevant for meaning (thus, also on synctactic ways of accounting for combinatorial aspects linked to compositionality).

Dummett assumes that molecolarism, as opposed to holism, allows for a heuristically interesting treatment of modalities of meaning, taken to be similar to fregean *Sinne*. He approaches this by asking a question concerning the very limits and status of what we may define the "epistemic space" of meaning. This is in turn taken as the set of propositional contexts relevant (primarily or indirectly) for comprehension of a language subsystem. These contexts actually exhibit the structure of information conveyed by the subsystems considered. They are therefore to be thought of as propositional contexts in the proper sense, that is: as an account of how the world would be if the understood propositions actually held (which is different form saying: if assertions expressing those propositions were true, in that it can be adapted to a non-classically truth functional definition of meaning such as Dummett's).

In the case of meaning analysis for logical constants the informational content exibithed by the propositional modality (set theoretic range of possibilities allowed) is a formal structure. That is, a formal partition on the considered fragment of reality establishing a meta-semantical (stipulated) pre-condition for semantical interpretation inside our formal universe. In a way, then, the formal structure of reality considered as the object of logical analysis is stipulated, as it depends directly on the consequences of stipulation for the meaning of logical constants. This meaning is in turn given in epistemic terms: it represents the epistemic pre-condition of access to semantical structures and regularities. An other way of putting it is by saying, as Dummett himself does, that the meaning of logical laws (axiomatizations of given semantics and consequent theorems and validities) depends directly on the meaning of logical constants.

One can obviously assign to logical constants different types of meaning. The main selector for these types is the specification of what kind of formal reality, *if any*, is described by constants. Here I shall assume, coherent with an anti-realist assumption (yet to be investigated), that this reality is an epistemic reality. It is, in other worlds, the structure described by our way of describing semantical structures. The structure of epistemic access to semantics is tipically *modal*. This is independent from our assuming that its semantical counterpart should be possible world semantics. Modality represents the basic meta-semantical notion also in those logical treatments of meaning and logical consequence relations where modal concepts such as possibility are taken to be merely synctatical tools, for example (indirectly) in intuitionistic logics.

We are therefore in the necessity to cope with the question of what a modal structure is, whether it is treated semantically or sinctactically. In other words, what is a possible world or an intuitionistic state of information, which turn into a (meta-)semantical structure as soon as they are operationalized by meaning stipulation for logical constants? Semantics for epistemic logic proper seems to be parasytic on such questions. They turn our attention to the epistemological question of what a possibility is. So: concerning what kind of propositional structure is taken into account in possible world semantics for epistemic logics when I conditionalize the meaning of a belief relation statement to the range of possibilities considered (and linked to each other by accessibility relations or synctactic sieves). The question also exhibits its obvious ontological

side: what happens when I take possibility to be a meta-semantical structure, therefore defining the limits of logical space. As we shall se, both these questions directly determine the heuristic and expressive capacity of epistemic systems. But let us first give a brief account of how the epistemological-ontological pair can be treated.

2. Wittgenstein and Carnap on possible worlds: ontology and semantics

Traditionally, there are two basic ways of confronting the question. The first is suggested by the essentialist approach found in the *Tractatus*; the second is typically Carnap's view on deductive logics and its abstract ontology.

Wittgenstein's *Tractatus* offers an important account of how modalility as a pre-semantical tool should be viewed. The account is based on a quasi-realist reduction of epistemology (how we should understand contextual meaningful structures) to metaphysics.

It then reduces the question concerning the structure of our epistemic access to meaningful configurations to the question of the latters' real structure – thus defining the notion of possibility as a realistic notion based on real (physical?) combinatory modalities.

Wittgenstein's modal atomism, as Bradley among others has defined it, plays on the notion of logical form, and on the general framework used to explain this notion, that is: a picture theory of language. In this account, logical form exhibits modality as the fundamental property of language, a property that (opposite to Frege's analysis of meaning as sense in indirect contexts, where modality turn up to be the new denoted) cannot be denoted because it defines the limits of denotation. As it is said in the *Notebooks,* giving the "nature of the proposition" can be equally thought as "giving the nature of all being" (January 22th 1915). In the Tractatus, propositions (information expressed by statements) are concatenations of names. Combinatory conditions of an object (thus of its denoting term) are assumed as a basic structure. Because of the shift of combinatory calculus from synctactic to semantical level, such conditions are the possibility conditions of factual structures in which an object can enter as a constituent. Logical form is thus a possibility of structure beared by objects. Objects are then defined by modal relations constituting "states of affairs". Possibility attains to states of affairs themselves (Tlp 2.061-062). A proposition (a propositional context) shows a formal partition on the set of all possible states of affairs relevant for object-name's meaning. It exhibits which states of affairs are made actual (as a meaning context for the atom-expression considered) and which ones are not. Consequently, "a proposition shows how things are, and says that they are so and so" (Tlp 4.022). Here the formal structure shown is the limiting pre-condition for what is said; therefore no analysis is possible on which criteria we have for selecting sub-structures relevant at each stage for the meaning of the language sub-systems considered. These criteria are not a matter of stipulation.

Thus if understanding a proposition means knowing what happens if it is true (if the assertion expressing it is true), the meta-semantical conditions on "what happens" cannot be represented and analysed in logical terms. This is because the analysis would then have as its object the set of possibility conditions one of whose sub-sets is the possibility condition of analysis itself.

Logical statements take as their object this formal structure, which is also their form. Thus, it is a non-sense, in Wittgenstein's terms, to proceed from the level of mere showing (e.g a tautology shows that it is a tautology) to that of representing (the conditions because of which the tautology is a tautology). The information context epressed by a proposition is then given in structural and non-epistemic terms. Its comprehension is at the same time the very limit of inferential process constituing meaning comprehension. Modality is here a tool for selection of possible sub-systems inside a universe-set, and it says nothing about itself (about the criteria for this selection). One may say that this depends partly from a fregean heritage (consisting in taking generality as the object of logical analysis), partly from a biased metaphysic view (assigning to generality a non-constructivist status). However, how strange as this might seem, similar problems are at issue also in a conventionalist approach like Carnap's, suggesting that something very important concerning the operational structure of modality (thus its epistemic properties) remains problematic. Better said, suggesting that a non-traditional ontological treatment of modality is strongly needed - one able to overcome classical disctinctions between realism and anti-realism for what concerns the informative charachter of possibility-selection structures as basic modal structures for meaning comprehension processes. Thus, for the truly epitemic component of meaning.

Carnap's treatment of modality can be viewd as a subset of semantic and synctatic analysis for mathematical and logical propositions. Since traditional empiricist criteria for significance cannot applied to denoted abstract entities of mathematics, the question arises of what constitutes a significance truth-functional criteria for abstract semantics. One needs to ask what kind of reality is described by synctactical constructions, e.g. to explicit the ontology underneath treatment of derivations and proofs and formulate hypothesis on what kind of status attains to epistemic structures and inferences (to the semantic selectors of posibilities relevant for comprehension of a language sub-system, since they also exhibit meta-semantical properties). Carnap's idea is that meaning is given by inferential connections from statements to verification or truth conditions, and that truth and falsity of mathematical statements is built into the very structure constitutive of these connections. So mathematics and logics study the articulation of inferential consequences admissible from systematic premises. Such premises are defined as merely conventional.

Consequently, modality is a property attaining to this epistemic (synctactical) structure. It therefore does not describe anything, since it contributes to define the way we refer to anything, which is exactly what is described by logics. In a way, all logic is epistemic, and its meta-semantical pre-conditions are not a matter of ontology or epistemology, but rather a pragmatic one. So structural necessity in meta-semantical terms, and concerning questions of foundation, is not ontological. It is an arbitrary criteria for conditionalization of possibilities inside the chosen logical net. Possibilities are then merely inferential tools, and completely de-substantialized.

Carnap's state descriptions are based on this approach. Think for example of the definition of L-equivalence as equivalence of an informational content which is defined by mapping inferential structures onto the formal synctactical criteria adopted for defining state descriptions. So, they are actually mapped onto themselves. The heuristic capacity of Carnap's modal logic seems to be none. It cannot give any account of the criteria for defining what

(state of affairs) is possible and what is not. It is true that intensions are defined in propositional terms: but then, in turn, a proposition refers to combinatory clusters of synctatical structures.

What we need here is a semantical tool to specify how the synctactic aspect of combinatory rules relates to the semantical notion of possibility, and how this relation tells us something about possibility meta-semantics. The notion of information conveyed by selection of relevant possibilities is here fundamental. It is clear that a condition for expliciting this notion is to adopt a propositional treatment of modality, on which epistemic structures are mapped. So that "possible states of the worlds" are in some way distinguished and related to epistemic inferential ways of having access to them. Classical examples of this approach are given by Hintikka's game theoretic semantics, by Fine's analysis of e.g. propositional disjunction, and finally by cluster-models for possible world semantics – where the latter directly takes into account the epistemological space in which semantics is viewed.

Generally, propositional semantics seem to be much more interesting than merely synctactical approaches. We shall better see this in viewing Konolige's logics and Levesque's system for implicit and explicit belief.

Before turning to these, just a brief observation. Ontological problems concerning possible worlds semantics have traditionally been treated in two different ways. One is typically Kripke's: ontology is given in terms of definition of identity and rigidity of designators. This is, however, an approach trying to fix the semantical space of modality from an estentional point of view. The second approach consists in saying what a possible world is directly in metaphysical terms: this is typically David Lewis'approach.

It seems that definitions in terms of semantics, which only as a second step tie semantics to ontology, are rather problematic. Even if we say that a possible world is a counterfactual, this does not tell us anything about the semantic and ontological structure of "counterfactuality". Nor, of course, we can give credit to the idea that a purely infra-systemic notion of a possible world as a maximal consistent set of well formed propositions is sufficient.

One might reply that this cluster of problems simply does not make sense. The idea would then be to leave out any meta-semantic option, and go for an interpretation of possible worlds as merely useful tools for logical analysis of correct and valid inferences in an axiomatized logical system. However, this will not do if the aim is to use possible world semantics for an epistemic theory of meaning. Here it seems essential to investigate the structure onto which epistemic inferences are built, taking seriously Frege's idea about links between *Sinn* and *Bedeutung*, both in terms of model-theoretic properties and of formally ontological assumptions. The question then becomes: since propositional modality carries the (formal) information about meaning, as well as its epistemic conditionalization to the structure exhibited by modality itself, then how is this conditionalization to be investigated? (Different ways of having access to what is denoted actually determine the structure of the process of information building implied by comprehension).

3. Two epistemic logics and relevant ontological questions

The concept of semantic information has been at the core of knowledge basis representation in AI. Two paths have traditionally been followed. The first one is given by attempts to represent conceptual links through semantic web and frames. This one we shall leave out, mostly because it is concerned with a specific way of tracing the link from semantics to ontology, linked to Carnap's meaning postulates and Putnam's basic properties of what is denoted, only secondarly concerned with the inferential structures of epistemic meaning comprehension processes. Instead, we shall briefly follow the path of formal ontology for epistemic structures, although in a way the two paths are obviously linked.

From the viewpoint of epistemic logic, modality is to be treated as the meta-semantical conditionalization of epistemic structures (knowledge and belief), functions and operations defined on semantics –the latter describing reasoning processes inside the logical modal space. A possible world can then be defined in terms of a state of information in propositional terms, and epistemic relations are mapped onto this structure to account e.g. for belief or knowledge semantical conditions from the viewpoint of set-theoretic semantics. Here a central notion seems to be that of propositional indeterminacy, for the treatment of which a non-normal modal approach to possible worlds is obviuosly required. The definition of propositional indeterminacy in epistemic logic has been a fundamental tool against logical omniscience.The notion of indeterminacy is parasytic on that of possibility, so again we are confronted with our basic problem. There are mainly two basic ways of treating indeterminacy and thus possibility, in formalizing information acquisition processes.

The first way is to use a synctactical approach, and Konolige's system, proposed in 1986, gives us an interesting example of it. The example is obviously linked with an internalist position such as Moore's and Hendrix's hypothesis – thus owing much to the psychologist account of epistemic modality, and very little to the idea that modality should be taken as something contibuting to explain how language fits some formal structure of reality. Konolige takes beliefs held by epistemic subjects to be sets of formulas, e.g. statements and not propositions, deductively closed under logically incomplete rules of inferences. Properties of beliefs are operationalized inside deduction structures associated with subjects. A deduction structure is a structure d(i) made up by a pair <b(i), ρ(i)> (a sub-set of believed formulas and a set of rules of inferences). Belief relation is then represented as a structure:

$$Bel(<b(i), \rho(i)>) = \{a \mid b(i) \vdash_{\rho(i)} a\}$$

The system is thought as a way to give account of provinciality of belief structures, that is: it is established that the number of premises for every rule application must be fixed and finite. So, every inference from a defined belief sub-set is independent from the whole belief set. Semantically, here you have a classical set-theoretic notion of interpretation for the non-modal sub-sets, plus the synctactic sieves for the modal formulas.

So, for example, $M \models p$ (for an atomic p) iff $\varphi(p)=t$; $M \models a\&b$ iff $M \models a$ and $M \models b$, and so on. For the modal belief relation: $M \models B_i a$ (that is: it is true under interpretation M that "a" is believed) iff $a \in Bel(d(i))$, where d(i) belongs to the set of deduction structures or points of view considered. For the axiomatization: the semantics is correct under PC axioms, *modus ponens*, a specification of a set of deduction rules for every deduction structure and, most important, a linking rule LR for which:

From $B_i a_1 \ldots B_i a_k$ and from $a_1 \ldots a_k \vdash_{\rho(i)} b$, it follows that $B_i b$.

The linking rule allows inferences through the link with synctactic structure in the model. Obviuosly the system does not use the notion of "possible world". It therefore tries to avoid problems concerning propositional possibility. Inferential structures produce a formal partition on the universe-set, dividing statements believed from statements not believed through the sieve given by synctactic consequence relations. These are in turned based on the meaning of logical constants, given in merely combinatory terms by the underliyng meta-linguistic theory. However, here the informative content of meaning is completely left out, precisely because there is no propositional structure onto which inference models are mapped onto. As a matter of fact, in synctactic models the latter are mapped onto themselves. This has in turn a consequence on the formal deduction relations: the only condition posed on a deduction is synctactic consistency, whereas the propositional approach suggests that epistemic modality must in some way be related to some stronger semantical condition specifying the formal structure of our way of believing (and knowing) things. In other words: something concerning the formal partition on reality considered must account for the way we relate to reality (here reality is intended in a weak sense: as a set of objects and links among objects, eventually computable as functions and operations on them). From our point of view, even if synctactical accounts such as Konolige's allow for acquisition of information through application of established deduction rules, this information is not at all an information properly (that is: something saying what kind of formal structure of reality should hold if the belief were taken to be true). Also: indeterminacy is taken to be only an inferential limit.

Propositional accounts of modal epistemic notions try to do for this; however, they are limited by lack of ontological investigation and semantical specification. Think for example of Levesque's logics for implicit and explicit belief (1985). Here the informative property of modality is accounted for through semantical indeterminacy –that is, by assuming non classical worlds and treating them as situations (where the terminology is an heritage from Barwise and Perry). Situations shape the sub-set of reality taken to be relevant for a subect's believes, and leave everything else as indeterminate. Of course the notion of "being indeterminate" is conditionalized to a determinate background of implicit beliefs. These describe "not what an agent takes to be true, but what reality would be if what he believes were true". Normal possible worlds are used to account for implicit belief; the semantics for explicit belief is given in terms of situations, propositional sub-sets whose intensions may well lack of a proper informative content (for example when situations are inconsistent, that is: there is at least a proposition of the sub-set to which both "t" and "f" are assigned, or incomplete, that is: the truth value assigned is Ø). Here the main interpretation schemes are given by:

i) M, s $\models_t$ *E*a iff M, s' $\models_t$ a for all situations s' belonging to B (set of beliefs)

ii) M, s $\models_f$ *E*a iff M, s $\nvDash_t$ *E*a

iii) M, s $\models_t$ *B*a iff M, s' $\models_t$ a for all s' belonging to W(B) (set of possible worlds consistent with beliefs)

iv) M, s $\models_f$ *B*a iff M, s $\nvDash_t$ *B*a.

While *B* is closed under implication, *E* (explicit belief) is not (we shall leave out examples of this, since they are quite obviuos to imagine if we consider inconsistent situations). Also, of course, *E*a → *B*a. The latter is again the obvious precondition for iii), since it states the condition at which possible world can complete incomplete situations for explicit belief. However, our problem turns up again. That is: which is the structure of the process of information acquisition allowing to know criteria for relevancy, so that what is indeterminate can at some point of inferential processes be determined?

Another very simple example of the problem can be found in a very common semantical property assigned to propositional belief relations. That is, the closure property with respect to set-intersection. So:

For every w belonging to the set W and for every proposition X and Y (thinkable as sets of worlds) :

If X∩Y ε N(w) (the latter being the sub-set of possible worlds, or the common sub-set of sets of propositions on which a modal function is considered), then X ε N(w) and Y ε N(w). (Also the inverse holds).

In propositional terms, and recalling wittgensteinian terminology, this means: if you know the possible state of affair in which a propositions' conjunction is true, then you know the possible states of affairs in which each one of the propositions considered is true. But what kind of information is given by this "then"? Shouldn't such an information be semantically specified by accounting for semantical properties of the notion of possibility itself? How does the introduction of new ways of defining concepts implies new information? And how is this information to be thought (for example: as an introduction of new state of affairs or as a specification of known ones)? Modal notions convey an information which is in some way ubiquous.

Some concluding remarks. A way to confront the semantical-ontological question of defining modal notions could be given by a strategic reduction of possibility to probability. Consequently, the notion of necessity would be treated as the conditionalizing reference term; in Kolmogorov's classical symbolism, necessity attains to the universe-set Ω, where Probability (Ω)=1. The axioms and formalizations of probability calculus could then be applied to epistemic calculus of belief and knowledge relations; something which would intuitively take up De Finetti's and Carnap's subjective interpretations of probability (De Finetti said that probabilities could be thought of as degrees of belief). This would seem at a first instance a nice way of relating language information-processing to some basic structure of reality, thus taking seriously both Maxwell's general idea that "the true logic of reality is the logic of probability" and Adams' version of probability as the study of propagation of probability in uncertain inferences (where both premises and conclusion are uncertain). The most interesting aspects of such an approach is probably given by what we are told by Kolmogorov's continuity and countable additivity axioms, establishing inversely proportional links between complexity of inferential processes and probabilities of conclusions.

On the other side, however, logical (as opposed to physical) interpretations of probability are confronted by general and specific problems similar to those attaining to the status of possibility and modal notions. So the question would be again: what shall we do with Wittgenstein's remarks, for which modality is to be taken as the very limit of the logical space?

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